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BUREAU OF STANDARDS

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ACCURATE RADIO-FREQUENCY TRANSMISSIONS ON 5,000 KC

In an announcement by the bureau published at the beginning of the year appearing in several technical magazines and the newspapers (TECHNICAL NEWS BULLETIN No. 165, p. 8; January, 1931) mention was made of the inauguration of an improved type of standard frequency transmission upon 5,000 kc. These signals are transmitted from 1.30 to 3.30 and 8 to 10 p. m., eastern standard time, three Tuesdays in the month. They represent a step in the program of ultimately providing continuous transmissions of accurately known frequency available in all parts of the United States.

The transmitting set is in a temporary location at College Park, Md., 10 miles from the National Bureau of Standards. The transmitted frequency is controlled by a standard piezo oscillator at the transmitter. Work has been begun on facilities for control of the transmissions by the primary frequency standard located at the bureau's main laboratory. As the transmitting station is now located adjacent to an experimental flying field, there are restrictions on the height at which an antenna may be built and its location, with the result that the radiated power is now severely limited.

The power in the present antenna system, which is a horizontal dipole one-eighth wave length above the ground, is less than 200 watts. In

spite of the limitations stated above, the signals have been utilized more than 2,000 miles away. This statement should not be construed as meaning that the transmissions are heard everywhere within a radius of 2,000 miles, because some reports from points a few hundred miles distant indicate that the reception there may not be reliable at the present times of transmission. Radio reception varies with the distance, time of day, season of the year, and frequency. It is likewise known to vary from year to year. A consideration of all of these elements affecting the transmission shows the magnitude of the problem of supplying universally available standard frequency service.

In working out the problem the bureau has asked for assistance from the many people engaged in radio work in various Government bureaus, the Army, the Navy, radio companies, measurement laboratories, and others. The bureau desires reports on the reception of these signals in various localities. The information desired includes time of reception, approximate field intensity, and degree of fading. The bureau appreciates the cooperation evidenced by the many reports which are being received, and which are helpful in the plans to improve the standard frequency service.

The accuracy of the 5,000 kc. transmissions is within 1 part in 1,000,000. Plans for the expansion of the service

cover the following, which are being undertaken as rapidly as possible: Increase in power output, transmission on one or two additional higher frequencies, further increase in accuracy and extension of time of transmissions.

#### THE ARC SPECTRUM OF ZIRCONIUM

Nearly 1,600 lines have been measured at the bureau in the arc spectrum of zirconium between 2,085 Å in the ultra-violet and 9,300 Å in the infra-red. Approximately 80 per cent of these lines, which includes all but 7 for which temperature classes have been determined, have been classified as combinations between terms of the singlet, triplet, and quintet systems. The terms, without exception, are those required by Hund's theory, and many of them have been confirmed by Zeeman effect observations. Many pairs of terms of nearly the same value, with the same inner quantum number, and arising from the same electron configuration, mutually perturb one another, with the result that lines originating in them exhibit abnormal intensities and Zeeman effects. The lowest term of the spectrum,  $a^1F$ , and the lowest term of the quintet system,  $a^5F$ , both form Rydberg series with higher terms, from which the distance separating the ground states of Zr I and Zr II proves to be  $56,077 \text{ cm}^{-1}$ , giving an ionization potential of 6.92 volts for the neutral Zr atom. The resonance lines are given by the combination  $a^1F-z^2G^o$ , whereas the raies ultimes are given by  $a^5F-z^2G^o$ . More than 200 Zr lines have been identified with dark lines in the solar spectrum, of which nearly half represent term combinations which do not appear in emission spectra observed in the laboratory.

These measurements will be reported in detail in the April number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

#### THE FEDERAL FIRE COUNCIL

Upon the invitation of the Secretary of Commerce, a meeting of representatives of Government departments and establishments was held last April to consider the possibility of joint action on fire prevention and protection for Government properties. An organization was formed, known as the Federal Fire Council, to function in advisory and informative capacity in this field. Included in its scope are the formulation of recommended standards or policies relating to such

items as exit requirements for buildings, protection of records, elimination of fire hazards, fire detecting and extinguishing equipment, and fire alarm and patrol service, unless already covered by interdepartmental agencies.

The activities of the organization are conducted mainly through committees concerned, respectively, with fire hazards, apparatus, and appliances, and coordination of inspection within the different departments and establishments. On request of Government officials concerned, inspections have been or are being made of welfare, correctional, and penal institutions in the District of Columbia, bureaus that will occupy quarters in recently completed Government buildings, and of the Capitol group of buildings. The offer of the National Fire Protection Association to conduct inspections of a number of institutions outside of Washington was accepted with appreciation, and engineers attached to the field service of this association are at present engaged on this project.

The Committee on Apparatus and Appliances assists the Fire Hazards Committee in its inspection projects on matters pertaining to needed fire-protection equipment. Its six subcommittees are also preparing material descriptive of the different types of fire-protective devices, such as manual fire extinguishers, permanently installed fire-extinguishing systems, fire-alarm equipment, motor-driven fire apparatus and pumps, protection for openings, and office furniture and equipment. This includes definitions of the useful scope of application and effectiveness of the devices concerned, together with approximate estimates of cost.

The Committee on Inspection and Interdepartmental Cooperation serves as a contact medium between agencies in the Government that are concerned with the fire hazard and assists in establishing such agencies where none now exist. At its organization meeting it was decided to obtain estimates of the amount, kind, and value of Government property subject to loss by fire, and information on protection measures taken. An inspection manual that will contain essential information on fire hazards and protection methods is being prepared for the use of the inspection groups.

Three quarterly meetings have been held at which reports of committees and other items of interest have been presented. An interesting report on

the institutions under the Board of Public Welfare of the District of Columbia was presented at the June meeting. At the October meeting a report on the Patent Office as it will be in the new Commerce Building was presented by the Fire Hazards Committee. The officials of the Patent Office are making every effort to safeguard the valuable records, library, and data under their care, as a serious fire might easily be a calamity to the commercial world. The new Commerce Building is of fire-resistive construction with a minimum amount of combustible interior trim. Attention has been given to the prevention of spread of fire from floor to floor by inclosure of openings, and floor areas have also been subdivided by suitable partitions and doors. For several years the Patent Office has been working out a program of replacement of wooden filing cases, book stacks and furniture, with metal equipment. This program is well under way, and it is expected that by the time the office moves into its new quarters in December, 1931, a large proportion of its occupancy will be so equipped.

At the same meeting the matter of protection for the book stacks in the new annex to be built for the Library of Congress was discussed. The book stacks in the present building are open from top to bottom, and a fire originating anywhere within the stacks would spread rapidly. In the new design, considerations are given to the possibility of providing fire stops at each stack level and maintaining smaller undivided areas than with the present stacks.

The general protection afforded books and records by the type of furniture and shelving used was discussed, and results of fire tests conducted at the National Bureau of Standards with office and record storage occupancy were presented.

At the recent January meeting a further report was presented on a Federal correctional institution in the District of Columbia, and representatives from the War and Navy Departments gave an account of fire prevention and protection activities within these departments.

The fire-prevention section of the office of the Quartermaster General is charged with the protection of property valued in excess of \$1,600,000,000. Purchases of fire-protection equipment are made on one proposal, to secure more advantageous prices and uniform equipment. Plans for new construction are reviewed and drawings

and specifications prepared for any new fire-protection equipment or water supplies that may be needed. Much progress has been made in the standardization of fire-fighting equipment, including the adoption of the national standard hose-coupling thread and a single design for pumping equipment mounted on the Army standard truck chassis.

The fire-prevention activities of the Navy Department divide themselves into two main divisions—those for land establishments and those for ships. The men afloat are made familiar with the fire hazards and methods of prevention and extinguishment common to ships by means of lectures, slide films, and drills, fire prevention being a subject in which a man must be proficient in order to be eligible for promotion.

In shore establishments special attention is given to housekeeping and watchman service. All shops and buildings are cleared of waste material and debris at the close of each day. Shore stations are equipped with modern fire-fighting equipment, and in addition each shop has its own organization that answers fire calls within the shop, using hand fire extinguishers and similar equipment until the arrival of the regular fire-fighting force.

As an indication of the effectiveness of the Navy's fire prevention and protection work on about \$600,000,000 worth of land property there has been an average annual loss of only \$35,000, or 6/1,000 of 1 per cent, over a period of three years. The per capita loss as figured on the number of employees is 60 cents, as compared with the Nation's fire loss of over \$3 per capita.

Contacts between those concerned with the care of property in the different departments are helpful in introducing the most effective methods of prevention and protection. In conjunction with the general work of the organization, it will aid in securing the application of sound, conservative principles. The complete elimination of possibility of fire is generally out of question, but a large percentage of fires originating from poor structural, maintenance, and housekeeping conditions can be prevented, and the destructiveness of such fires as do occur can be greatly reduced by proper recognition of hazards and application of the most effective means of prevention, detection, and extinguishment. Such good fortune as the Government has had in avoiding serious fire losses may be attributed largely to good con-

struction, good housekeeping, and a limited amount of fire-protection equipment maintained in good condition. Extension and more general application of this practice with further elimination of unnecessary hazards introduced by interior finish and equipment of buildings should aid in further decreasing the fire loss on buildings, many of monumental type, on records, works of art, and other building contents that are irreplaceable or of high monetary or historic value.

#### THE VIBRATION OF U BARS

A theoretical study has been made at the bureau of elongated and short U bars with special reference to their use as vibrators in investigations of elastic hysteresis.

First, an expression for the frequency of the fundamental mode of vibration of the elongated U bar is derived by solving the differential equations of motion of the yoke and of the prongs through the use of an approximation. The physical basis for the approximation is the fact that the bar vibrates with a pitch differing slightly from that of the clamped-free bar of half the length.

Secondly, Ritz's method of approximation is developed for initially curved bars, the development being based on the principle of least action. In this connection a new proof of the short U bar, such a bar being determining the fundamental mode of vibration. As an illustration of Ritz's method, the example of the free-free bar is treated, and the results of the calculation are compared with the known solution of this problem. Next, the method is used to determine the fundamental mode of vibration of the short U bar, such a bar being defined as one wherein the length of the curved portion, or the yoke, is equal to the sum of the lengths of the two parallel prongs.

Finally, Rayleigh's method is used to determine the static deformation of the short U bar, produced by the application of a single load so applied that the deformation is most nearly that present in the fundamental mode of vibration.

This investigation will be more fully discussed in the April number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

#### HEAT TREATMENT OF GLASS

A paper to be published in the April number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH shows some of

the variations found in the heating curves of a glass when it is chilled or annealed in varying degrees. A discussion is included which is designed to explain the relation of these variations to certain assumed changes in the physicochemical condition of glass as its "effective" annealing temperature is varied. The relation which these changes in condition bear to the properties of a glass and to some phases of the problem of annealing is also considered. It is evident from both the experimental results and these discussions that annealing procedures may be so manipulated that certain properties of the glass may often be made either more desirable or more nearly coincident with standards of requirement than they would be if a fixed (or indefinite) annealing schedule were always followed for a given type of glass.

#### GASES EVOLVED BY FELDSPAR DURING HEATING

The Columbus Branch of the bureau is now studying the gases evolved by some feldspars during heating. The feldspar samples used are the same as those which the bureau has been studying extensively and for which data were published in the Journal of the American Ceramic Society, January, 1931. It has been known for a considerable time that some feldspars fuse to a clear bubble-free glass, while others form only an opaque glassy mass, the opacity presumably being the result, in some cases, of inclosed bubbles containing gas. The investigation has for its purpose the determination of the amount of gases given off as well as some indication of their relative compositions.

The procedure and apparatus used are similar to those developed at the Washington laboratory for the determination of the gaseous constituents of metals. A 10 g sample is heated in a fused silica test tube, contained within a larger fused silica tube which is closed at one end. A platinum resistance furnace is used. The open end of the large fused silica tube is sealed by means of a brass unit to a glass vacuum apparatus. The apparatus is evacuated to about 2 mm pressure before the furnace is heated. The gases evolved during the heating are continuously circulated by means of a mercury vapor pump through a closed circuit containing (1) a phosphorous pentoxide absorption tube which removes the water and (2) an absorption tube containing Ascarite (sodium-hydroxide-asbestos absorb-

ent) which removes the acid anhydrides, carbon dioxide, sulphur dioxide, etc. Means are provided for cutting out either absorption tube from the closed circuit. The gain in weight of the tubes given the quantitative determination of the gases.

Nineteen feldspars have been used in determinations up to 1,000° C., and several samples have been rechecked. The total weight of gases drawn off at 1,000° C. from the various feldspar samples varies from 0.2 per cent up to 1.0 per cent and follows closely the loss on ignition of the feldspar. It has been found that the gases may contain from 35 to 96 per cent (weight percentage) water vapor, but usually between 70 and 85 per cent. The acid anhydrides are nearly always present in determinable amounts and vary from 0.1 up to 55 per cent and usually between 4 and 12 per cent. The other gases comprise the remainder, and vary from 3.5 to 19 per cent but usually lie between 7 and 15 per cent. This indicates that the loss on ignition above 110° C. is in most cases not all water vapor and that in calculating chemical analyses back to mineralogical composition we are not justified in using all the loss on ignition as a basis for calculation of kaolinite. This explains why in calculated mineralogical compositions of feldspar more kaolinite is obtained than is actually found to be present by microscopic methods.

#### EFFECT OF PROLONGED BOILING, AUTOCLAVE TREATMENT, AND DRYING ON THE WATER ABSORPTION OF EARTHENWARE

This phase of the work was undertaken to determine:

1. Whether or not representative earthenware could be completely saturated with water by the commonly used boiling method.

2. The rate at which absorption progressed.

3. What percentage of the pores could be filled in the event that absorption did reach or approach completion.

Samples broken from two plates of each of 16 brands were used and were boiled progressively for 240 hours. Weighings were taken at 1, 2, 5, 10, and 20 hour intervals and thereafter at 20-hour intervals. The specimens were then immersed in water and autoclaved at 150 lbs./in.<sup>2</sup> for 11 hours.

After the 240 hours' boiling and 11 hours' autoclave treatment the average absorption for the 16 brands was 9.97 per cent. The absorption after 200 hours of boiling was 9.64 per cent,

after 120 hours 9.15 per cent, after 80 hours 8.72 per cent, after 40 hours 8.22 per cent, after 10 hours 7.6 per cent, and after 5 hours 7.4 per cent. Therefore, the present standard 5-hour boiling test is approximately 75 per cent as efficient as 240 hours' boiling plus 11 hours' autoclave treatment. That the gain in weight was caused primarily by mechanical filling of the pores, and not by absorption or possibly rehydrating, is evidenced by the fact that nearly all of the water taken up by the specimens could be driven off at 110° C. Average values for the 16 brands showed only 1.34 per cent moisture remaining after 1 hour of drying at 110° C. and 0.31 per cent after 6 hours' drying. The percentage of total pores not filled by this 251-hours' treatment was calculated by the following formula for duplicate specimens of four brands of ware:

$$p = \left\{ 1 - \frac{W_w - W_d}{V_b - V_c} \right\} \cdot 100$$

where

$p$  = per cent unfilled pores.

$W_w$  = weight of saturated specimen.

$W_d$  = weight of dry specimen.

$V_b$  = bulk volume.

$V_c$  = calculated solid volume,

$$= \frac{W_d}{\text{true specific gravity}}$$

The values obtained were: Brand 2, 19.5 and 19.3 per cent; brand 8, 20.8 and 21.0 per cent; brand 14, 11.5 and 11.3 per cent; brand 15, 20.0 and 21.8 per cent.

In order to determine the efficiency of autoclave treatment as compared with boiling, two specimens of six different brands were dried at 110° C. and subjected for 10 hours to the action of water under 150 lbs./in.<sup>2</sup> pressure, the specimens being immersed. The following results were obtained:

Water absorption after—	Brand Nos.					
	4	5	8	9	10	15
240 hours boiling..	P. d. 12.0	P. d. 11.7	P. d. 10.0	P. d. 10.1	P. d. 10.9	P. d. 10.0
10 hours autoclave treatment.	11.0	11.8	10.2	9.3	11.0	11.2
Difference..	-1.0	+1	+2	-.8	+1	+1.2

These values indicate that a 10-hour autoclave treatment at 150 lbs./in.<sup>2</sup> pressure may be as effective as 240 hours of boiling in filling the pores of typical earthenware bodies.



## CUTLERY MARKING OF CHINAWARE

A preliminary item on this investigation was published in *TECHNICAL NEWS BULLETIN* No. 153 (January, 1930). As explained in this item, the attention of the bureau has been directed a number of times to the so-called cutlery marking of tableware. These marks resemble lines made with a lead pencil on paper and can be made without exerting any more pressure on the metal, such as a silver-plated knife, than would normally be used in drawing the knife across a plate.

The preliminary investigations showed that an excess of carbon in a furnace atmosphere at 860° C. would not produce a surface susceptible to metal marking, even though the glaze had been darkened sufficiently by reduction of the lead to make the ware unmarketable. Preliminary work with undetermined concentrations of introduced  $\text{SO}_2$  showed that surfaces susceptible to marking could be produced by "sulphuring." Further experiments with measured concentrations of introduced  $\text{SO}_2$  at 860° C. for one-half hour gave the following results:

1. Concentrations of  $\text{SO}_2$  gas in the furnace atmosphere as high as 1.2 per cent did not produce a surface on any of the specimens tested which could be metal marked.

2. The only glaze showing harmful defects (blisters) after exposure to from 0.1 to 1.2 per cent  $\text{SO}_2$  was on a colored vitrified body.

3. Increasing the concentration of  $\text{SO}_2$  from 0.1 to 1.2 per cent increased the susceptibility of the surfaces to scratching with metal, particularly with nickel and steel.

4. Three per cent  $\text{SO}_2$  in the furnace atmosphere was sufficient to dull the glaze on two typical hotel ware and two earthenware bodies.

5. Concentrations of  $\text{SO}_2$  of 3 and 5 per cent caused the glaze on one brand of vitrified, low-fired ware to metal mark, but produced no blistering or scumming. Concentrations of 7.5, 10, and 12.5 per cent produced a slight scum, impaired the gloss, the metal marks could not be entirely removed by washing from the specimens exposed to a concentration of 12.5 per cent, and the scum formed was composed at least partly of lead sulphate.

In the course of this study a secondary phenomenon was observed which would be of considerable importance to one studying cutlery marking. It was noted that the surfaces could be marked after every test if

the marking was tried shortly after the specimens were removed from the oven and before they had been washed. Sufficient evidence was obtained to indicate that the glass surfaces dried by heating at temperatures above 400° C. will mark, whereas a surface protected with a film of adsorbed moisture, acting as a lubricating film, will not mark.

## PROPOSED NATIONAL STANDARD FOR LEATHER BELTING

The beginning of work on the development of national standard specifications for leather belting to permit the purchase on a scientific basis of the \$30,000,000 worth of leather belting for driving machinery required annually by American industry has been approved by the American Standards Association. The general adoption of national standards for belting would result in savings of several million dollars annually, according to estimates based on the experience of industries in which belting specifications are used. Work on the project will be undertaken immediately by a technical committee made up of representatives of manufacturers, distributors, large industrial users of leather belting, and Government departments. The American Society of Mechanical Engineers will direct the technical work of the committee under the procedure of the American Standards Association.

The United States Navy, the United States Steel Corporation, the New York Central Railroad, and a number of other organizations now purchase their leather belting on specifications. An attempt will be made to unify existing specifications for vegetable-tanned leather belting which constitutes about 90 per cent of the belting produced, into a single specification which will be nationally acceptable to the various industries so that the benefits of standardization will be available to both large and small purchasers. The committee's work will include consideration of raw material, construction, marking, and physical and chemical tests.

The need for American Standard specifications was first pointed out by the American Society of Mechanical Engineers in 1928. Considerable study has been given to the subject since that time and a general conference of representatives of technical societies, trade associations, and Government departments having an interest in the subject was held early in 1930.

## ERIMETER FOR GRADING WOOL

In the grading of wool for manufacturing purposes the average diameter of the fibers is a dominant dimensional characteristic of the material which serves as the present basis for the classification. Sets of wool standards have been established for the industry based entirely on the average diameter of the fibers. In present trade practice the grading is done by men of long experience in the industry who, by merely observing and handling the material, assign it intuitively to its proper grade. There is no suitable instrument available for the rapid, convenient, and accurate evaluation of wool on the established basis.

A simple rapid optical method for measuring the average diameter of a group of fibers was devised by Thomas Young in 1824, but no thorough investigation has ever been made of the practical possibilities of this method in the grading of wool. The method is based on the phenomenon of diffraction, which is manifested when a line source of light is viewed through a bundle of fibers which are arranged approximately parallel to one another and to the source. Under these conditions a banded light distribution is seen extending laterally and symmetrically on both sides of the source, and the separation of the bands is (to a close approximation) inversely proportional to the average diameter of the fibers.

In a paper to be published in the BUREAU OF STANDARDS JOURNAL OF RESEARCH for April a new construction of Young's instrument (the erimeter) is described in which a stationary artificial light source is used and more convenient and accurate means supplied for determining the separation of the diffraction bands. Comparative diameter measurements are made with the erimeter and with a microscope on wool and other textile fibers. The samples studied cover a range of average diameters from  $13\mu$  to  $50\mu$ .

From the microscope measurements on 12 wool samples diameter-frequency distribution curves are obtained for each sample. These data are used to illustrate the wide dispersion of diameters which are collected into a single averaged result by the erimeter. On the average, this range of variation extends to  $\pm 40$  per cent from the mean with an average deviation of roughly 10 per cent. The diffraction method is not suitable for the averaging of all possible diameter distributions. The

diameter distribution should not cover a wide range of variation combined with a frequency curve which is very flat or irregular. For best results there should be a pronounced concentration of diameters about a single class.

It is shown that the precision and accuracy of the erimeter are quite sufficient for the intended purpose. The erimeter averages for 12 wool samples all fall within  $2\mu$  of the corresponding values obtained by averaging many individual determinations with the microscope.

An investigation is made of sources of error arising from irregularities in form and orientation of the fibers, such that the theoretical condition of parallelism between the fibers is not fulfilled closely. This possibility of error may be reduced to negligible proportions by reasonable care in the mounting of the fibers and is not regarded as of serious practical importance.

Further developments in the construction of the erimeter are outlined by which a larger area of the sample may be observed and some quantitative information on the dispersion of diameters obtained.

## BURSTING STRENGTH TEST FOR PAPER

A common method of making the so-called bursting strength test of paper is with an instrument in which the paper is clamped over an orifice through which a rubber diaphragm is expanded against the paper by hydraulic pressure. An extensive investigation of alleged variables in this method of test was reported in the February, 1931, BUREAU OF STANDARDS JOURNAL OF RESEARCH as Research Paper No. 278, Critical Study of the Bursting Strength of Paper. The study included clamping pressure, nature of clamping surfaces, size of bursting orifice, types of diaphragms, effect of manner of installation of diaphragms, effect of air entrapped under diaphragm, speed of operation, effect of viscosity of liquid medium in hydraulic chamber, calibration and performance of pressure gauges, relation of bursting to tensile results, and relation of size of bursting orifice to bursting pressure. A device is described for measuring the vertical deflection of the paper in the bursting test.

As a result of the investigation it is recommended that a clamping pressure be used corresponding to a total load on the specimen of approximately

1,000 pounds for the 80 and 160 point testers and approximately 600 pounds for the 20-point tester. An all-metal clamping head having a sand-blasted clamping surface and a bursting orifice 1.200 inches in diameter is recommended to replace the rubber-faced clamping head formerly used. No evidence was found that the type of diaphragms ordinarily used, the manner of installation, air under the diaphragm, speed of operation of tester, or the viscosity of the hydraulic medium used have any appreciable effect upon the test. Careful consideration is necessary in the calibration of gauges, as the dials of many gauges commonly used on bursting testers are so poorly graduated that calibrations made at the major divisions may be meaningless in the adjacent subdivisions. Ethylene glycol or glycerin may be used in dead-weight gauge testers so as to prevent oil from reaching the rubber diaphragms. The equation  $PR=2T$ , in which  $P$  is the bursting pressure,  $R$  the radius of curvature of the paper at rupture in the bursting tester, and  $T$  the machine direction tensile breaking strength per unit width, relates the bursting and tensile properties and enables a correlation to be made of data obtained with different sizes of bursting orifices.

#### ALPHA CELLULOSE CONTENT AND COPPER NUMBER OF PAPER

The alpha cellulose content of cellulose materials is determined by subjecting the cellulose to the action of sodium hydroxide of mercerizing strength for a definite period of time. The copper number is the weight of copper, in grams, reduced from an alkaline copper solution by 100 g. of the cellulose material. Both of these determinations are of much value in determining the purity of cellulose materials and have been used by the bureau for determining the purity of the cellulose in paper in connection with its work on the permanence of paper.

However, paper is unlike most other cellulose materials in that the fibers are compressed into a dense, compact sheet and are protected by sizing materials. This formation makes reactions with chemical reagents slow and often incomplete. To avoid the possible errors caused by incomplete reactions the usual procedures for determining the alpha cellulose content and copper number of cellulosic materials have been modified so that they

are better adapted for the analysis of paper.

The modification considered of prime importance is the reduction of the paper to a cottonlike form by mechanical disintegration. A grinder devised especially for this purpose will be described in detail in the April number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH. Accompanying data show the necessity for grinding papers before these tests are made.

The alpha cellulose method is based upon that of Jentgen with modifications suggested by Parsons and Ross and other modifications developed at the bureau. The paper includes data on the accuracy of the method and reproducibility of the results. The percentage values are easily reproducible by different analysts within 0.3. Errors caused by the amounts of sizing materials in the paper are pointed out and the procedure to avoid them is outlined. A comparison of the results obtained with this modified procedure was made with the results obtained with the tentative method of the cellulose division of the American Chemical Society. The two methods agree very well when the test specimen is in the disintegrated form in both.

The copper number method is based upon the method of Braid and Knecht and Thompson with a few modifications developed at the bureau. Most copper number methods employ Fehling solution as the copper containing reagent, but these methods are subject to inaccuracies caused by the auto-reduction of the solution and by the alteration of the cellulose by the high alkalinity. The Braid method replaces the sodium hydroxide of the Fehling solution with sodium carbonate and sodium bicarbonate which is much less alkaline. The results of a comparison of the Braid method with a method employing Fehling solution, formerly used at the bureau, show that the Braid method has an average error one-third as large as the Fehling solution method. Results obtained by the Braid method can be duplicated within 1 per cent.

#### MULTIPLE CYCLE STRESS-STRAIN MACHINE FOR RUBBER

The bureau has recently built and installed a machine for automatically recording stress-strain properties of rubber compounds. The machine, which is designed for investigational work on the properties of rubber, is arranged for operation in many different ways. The speed may be varied



within quite wide limits down to about 1 cycle per second. Ring test specimens 2 inches inside circumference are ordinarily used and may be stretched any amount up to 1,000 per cent. By means of a series of calibrated springs the capacity of the machine may be set at values between 5 and 50 pounds; thus, a spring may be used to suit the particular sample under test. The stress-strain curves which are usually complete hysteresis diagrams are recorded on waxed stylograph paper.

#### LAUNDRY "WINTER DAMAGE"

When laundered cotton fabrics are dried outdoors in the winter time in New England, they frequently undergo excessive deterioration of a type called "winter damage." A paper to be published in the BUREAU OF STANDARDS JOURNAL OF RESEARCH for April is concerned with an investigation of the causes of "winter damage" and with its prevention.

Analyses of damaged fabrics and experimental work in the laundries and in the bureau's laboratory showed that the damage is caused by sulphuric acid which is formed in the damp fabric by the oxidation of atmospheric sulphur dioxide. The oxidation is accelerated and the damage is increased by small amounts of certain substances which may occur in laundered fabrics. Traces of iron, of spent bleach liquor, and of acetic acid were found to have this effect.

A small amount of calcium bicarbonate in the final rinse water of the wash materially reduced the damage and is recommended as a satisfactory remedy. Precautions should be taken to eliminate iron and spent bleach liquor from the laundered fabrics, and the drying time should be made as short as possible. Antioxidants showed promise of giving protection.

#### ERROR ON PAGE 18 OF TECHNICAL NEWS BULLETIN No. 166

Several errors occurred in the item entitled "Resistance of Metals Suitable for Dies to the Abrasive Action of Plastic Clays" on page 18 of TECHNICAL NEWS BULLETIN No. 166. The last paragraph should read:

If  $y = \frac{x}{c}$  represents the equation for metal A and  $z = \frac{x}{d}$  for metal B, where the extrusion pressure "x" is the same, then  $cy^n = dz^n$ , from which the comparative abrasion losses of the two metals can be calculated.

#### NEW AND REVISED PUBLICATIONS ISSUED DURING FEBRUARY, 1931

##### Journal of Research<sup>1</sup>

Bureau of Standards Journal of Research, Vol. 6, No. 2, February, 1931 (RP Nos. 268 to 278, inclusive). Obtainable by subscription. (See footnote.)

##### Research Papers<sup>1</sup>

(Reprints from Journal of Research)

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##### Commercial Standards Monthly<sup>1</sup>

Commercial Standards Monthly, Vol. 7, No. 8, February, 1931. Obtainable by subscription. (See footnote.)

##### Technical News Bulletin<sup>1</sup>

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*Building and Housing*<sup>1</sup>

- BH14. Recommended minimum requirements for fire resistance in buildings. Report of the Department of Commerce Building Code Committee. Price, 10 cents.

OUTSIDE PUBLICATIONS<sup>2</sup>

- A survey of current inlay casting technics. N. O. Taylor and G. C. Paffenbarger; *Journal, American Dental Association* (Chicago, Ill.), Vol. XVII, p. 2058; November, 1930.
- A specification for dental impression compound. N. O. Taylor, W. T. Sweeney, and G. C. Paffenbarger. *Journal, American Dental Association* (Chicago, Ill.), Vol. XVIII, p. 53; January, 1931.
- A specification for inlay casting wax. N. O. Taylor, G. C. Paffenbarger, and W. T. Sweeney; *Journal, American Dental Association* (Chicago, Ill.), Vol. XVIII, p. 40; January, 1931.
- An optical coincidence gage. I. C. Gardner; *American Machinist* (New York, N. Y.), Vol. 74, p. 155; 1931.
- Delicate device used to compute weight of earth. Paul R. Heyl; *United States Daily* (Washington, D. C.), Vol. VI, No. 2, p. 4; March 5, 1931.
- Strength of rectangular flat plates under edge compression. Louis Schuman and Goldie Back; *National Advisory Committee for Aeronautics* (Washington, D. C.), Report No. 356; 1931.
- Machinability and tool life. T. G. Digges; *Metals and Alloys* (New York, N. Y.), Vol. II, No. 2, p. 44; February, 1931.
- Wear of metals. S. J. Rosenberg and H. K. Herschman; *Metals and Alloys* (New York, N. Y.), Vol. II, No. 2, p. 52; February, 1931.
- Bismuth alloys. J. G. Thompson; *Metals and Alloys* (New York, N. Y.), Vol. II, No. 2, p. 92; February, 1931.
- The Government in ceramics. Ceramic division staff; *Ceramic Age* (Newark, N. J.), Vol. 17, No. 3, p. 129; March, 1931.
- Measuring units are improved by Federal agency. George K. Burgess; *United States Daily* (Washington, D. C.), Vol. V, No. 289, p. 4; February 10, 1931.
- New activities of Bureau of Standards outlined. George K. Burgess; *United States Daily* (Washington, D. C.), Vol. VI, No. 4, p. 4; March 7, 1931.

<sup>1</sup> See footnote on p. 31.

<sup>2</sup> "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

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